

WHAT IS CLAIMED IS:

1. An exposure method that immerses, in liquid,
a surface of an object to be exposed, and a surface of
5 a projection optical system closest to the object, and
projects a repetitive pattern formed on a mask via the
projection optical system onto the object, said
exposure method forming on a pupil of the projection
optical system an effective light source that emits,
10 from an axis orthogonal to an optical axis of the
projection optical system, light that is parallel to
the line direction of the fine patterns and has an
incident angle θ upon the object, wherein the light
includes only s-polarized light in an area of an
15 incident angle θ that satisfies $90^\circ - \theta_{NA} \leq \theta \leq \theta_{NA}$,
where θ_{NA} is the largest value of the incident angle θ .

2. An exposure method according to claim 1,
wherein the area has a canoe shape formed by
20 intersecting two circles.

3. An exposure method according to claim 1,
wherein the area has a shape by linearly cutting down
part of a circle.

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4. An exposure method according to claim 1,
wherein the area has a shape by linearly cutting down
part of an annulus.

5 5. An exposure method according to claim 1,
wherein the area has a circular shape.

6. An exposure method that transfers a pattern
formed on a mask onto an object to be exposed via a
10 projection optical system that is at least partially
immersed in liquid and has a numerical aperture of $n_0 \cdot \sin\theta_{NA}$, where n_0 is a refractive index of the liquid,
said exposure method illuminating exposure light so
that where an X-axis is one direction of the pattern
15 formed on the mask and a direction orthogonal to the X-
axis, a Y-axis is the other, and θ is an incident angle
of the exposure light upon the projection optical
system, an area of an effective light source formed on
a pupil of the projection optical system corresponds to
20 the incident angle θ that satisfies $90^\circ - \theta_{NA} \leq \theta \leq \theta_{NA}$
and has a linearly polarized component in a direction
orthogonal to the X-axis or Y-axis.

7. An exposure method according to claim 6,
25 wherein the area has a canoe shape formed by
intersecting two circles.

8. An exposure method according to claim 6,
wherein the area has a shape by linearly cutting down
part of a circle.

5 9. An exposure method according to claim 6,
wherein the area has a shape by linearly cutting down
part of an annulus.

10 10. An exposure method according to claim 6,
wherein the area has a circular shape.

15 11. An exposure method that transfers a pattern
formed on a mask onto an object to be exposed via a
projection optical system that is at least partially
immersed in liquid, said exposure method irradiating
only s-polarized light onto an area on an effective
light source formed on a pupil of the projection
optical system, on which area two imaging exposure
beams generate an orthogonal state.

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12. An exposure method according to claim 11,
wherein the area has a canoe shape formed by
intersecting two circles.

25 13. An exposure method according to claim 11,
wherein the area has a shape by linearly cutting down
part of a circle.

14. An exposure method according to claim 11,
wherein the area has a shape by linearly cutting down
part of an annulus.

5 15. An exposure method according to claim 11,
wherein the area has a circular shape.

16. An exposure method for transferring a pattern
formed on a mask onto an object to be exposed via
10 exposure light having a wavelength λ and a projection
optical system that is at least partially immersed in
liquid and has a numerical aperture of $n_0 \cdot \sin\theta_{NA}$,
where n_0 is a refractive index of the liquid, wherein
the liquid has a thickness d in an optical-axis
15 direction of the projection optical system which
satisfies $d \leq 3000 \cdot \lambda \cdot \cos\theta_{NA}$.

17. An exposure method for transferring a pattern
formed on a mask onto an object to be exposed via a
20 projection optical system that is at least partially
immersed in liquid, wherein a surface of the projection
optical system closest to the object contacts the
liquid and is protected from the liquid.

25 18. An exposure apparatus for transferring a
pattern formed on a mask onto an object to be exposed,
said exposure apparatus comprising:

a projection optical system that is at least partially immersed in liquid and has a numerical aperture of $n_0 \cdot \sin\theta_{NA}$, where n_0 is a refractive index of the liquid; and

5 a polarization control part for controlling polarization on an area on a pupil of said projection optical system which corresponds to a range of an angle θ at which exposure light exits from the projection optical system, the range satisfying $90^\circ - \theta_{NA} \leq \theta \leq \theta_{NA}$,
10 where θ_{NA} is the largest value of the incident angle θ .

19. An exposure apparatus according to claim 18, wherein the polarization control part sets the polarization to only s-polarized light.

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20. An exposure apparatus according to claim 18, wherein the polarization control part includes a polarization element arranged approximately conjugate to a pupil surface of the projection optical system.

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21. An exposure apparatus according to claim 18, wherein the polarization control part includes an aperture stop arranged on a pupil surface of the projection optical system, wherein the aperture stop
25 has an aperture shape that is a canoe shape formed by intersecting two circles.

22. An exposure apparatus according to claim 18,
wherein the polarization control part includes an
aperture stop arranged on a pupil surface of the
projection optical system, wherein the aperture stop
5 has an aperture shape by linearly cutting down part of
a circle.

23. An exposure apparatus according to claim 18,
wherein the polarization control part includes an
10 aperture stop arranged on a pupil surface of the
projection optical system, wherein the aperture stop
has an aperture shape by linearly cutting down part of
an annulus.

15 24. An exposure apparatus according to claim 18,
wherein the polarization control part includes an
aperture stop arranged on a pupil surface of the
projection optical system, wherein the aperture stop
has a circular aperture shape.

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25. An exposure apparatus according to claim 18,
wherein the polarization control part maintains
contrast of about 0.7 through control.

25 26. An exposure apparatus for transferring a
pattern formed on a mask onto an object to be exposed,
said exposure apparatus comprising:

a projection optical system that is at least partially immersed in liquid; and

a polarization control part for controlling a polarization on an area on a pupil of said projection optical system, on which area two imaging exposure beams generate an orthogonal state

27. An exposure apparatus according to claim 26, wherein the polarization control part sets the polarization to only s-polarized light.

28. An exposure apparatus according to claim 26, wherein the polarization control part includes a polarization element arranged approximately conjugate to a pupil surface of the projection optical system.

29. An exposure apparatus according to claim 26, wherein the polarization control part includes an aperture stop arranged on a pupil surface of the projection optical system, wherein the aperture stop has an aperture shape that is a canoe shape formed by intersecting two circles.

30. An exposure apparatus according to claim 26, wherein the polarization control part includes an aperture stop arranged on a pupil surface of the projection optical system, wherein the aperture stop

has an aperture shape by linearly cutting down part of a circle.

31. An exposure apparatus according to claim 26,
5 wherein the polarization control part includes an aperture stop arranged on a pupil surface of the projection optical system, wherein the aperture stop has an aperture shape by linearly cutting down part of an annulus.

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32. An exposure apparatus according to claim 26,
wherein the polarization control part includes an aperture stop arranged on a pupil surface of the projection optical system, wherein the aperture stop
15 has a circular aperture shape.

33. An exposure apparatus according to claim 26,
wherein the polarization control part maintains contrast of about 0.7 through control.

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34. An exposure apparatus comprising a projection optical system that transfers a pattern formed on a mask onto an object to be exposed, said exposure apparatus immersing, in liquid, a surface of the object,
25 and a surface of the projection optical system closest to the object, and satisfying $d \leq 3000 \cdot \lambda \cdot \cos\theta_0$,
where $n_0 \cdot \sin\theta_0$ is a numerical aperture of the

projection optical system, n_o is a refractive index of the liquid, λ (nm) is a wavelength of light used for exposure, and d is a thickness of the liquid in an optical-axis direction of the projection optical system.

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35. An exposure apparatus according to claim 34, further comprising a sputtered film, wherein the surface of the projection optical system closest to the object contacts the liquid, and is located on a calcium fluoride substrate and covered with the sputtered film.

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36. A device manufacture method comprising the steps of:

exposing an object using an exposure apparatus; and
developing the object that has been exposed, wherein the exposure apparatus includes:
a projection optical system that is at least partially immersed in liquid and has a numerical aperture of $n_o \cdot \sin\theta_{NA}$, where n_o is a refractive index of the liquid; and

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a polarization control part for controlling a polarization on a area on a pupil of said projection optical system which corresponds to a range of an angle θ at which exposure light exits from the projection optical system, the range satisfying $90^\circ - \theta_{NA} \leq \theta \leq \theta_{NA}$, where θ_{NA} is the largest value of the incident angle θ .

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37. A device manufacture method comprising the steps of:

exposing an object using an exposure apparatus; and

5 developing the object that has been exposed, wherein the exposure apparatus includes:

a projection optical system that is at least partially immersed in liquid; and

a polarization control part for controlling a
10 polarization on a area on a pupil of said projection optical system, on which area two imaging exposure beams generate an orthogonal state.

38. A device manufacture method comprising the
15 steps of:

exposing an object using an exposure apparatus; and

developing the object that has been exposed, wherein the exposure apparatus includes a
20 projection optical system that transfers a pattern formed on a mask onto the object, said exposure apparatus immersing, in liquid, a surface of the object, and a surface of the projection optical system closest to the object, and satisfying $d \leq 3000 \cdot \lambda \cdot \cos\theta_0$.

25 where $n_0 \cdot \sin\theta_0$ is a numerical aperture of the projection optical system, n_0 is a refractive index of the liquid, λ (nm) is a wavelength of light used for

exposure, and d is a thickness of the liquid in an optical-axis direction of the projection optical system.